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SPRUCE BUDWORM PROGRESS REPORT
1947

By

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W. D. Buchanan

In the central and southern Rocky Mountain Region the spruce budworm, Archips fumiferana feeds upon Douglas-fir, alpine fir, white fir, corkbark fir and less upon Engelmann spruce and blue spruce. There is also a form that feeds upon ponderosa pine. In the forests in Colorado, budworm populations that were more or less high have almost disappeared during the past 3 years, but they remain high in parts of northern New Mexico. In 1947 populations of the pine form budworm rose to a high level in some areas of the Black Hills, and caused considerable defoliation of ponderosa pine. In 1947 as in the past, the Fort Collins, Colorado Forest Insect Laboratory has directed most of its budworm activities to the collection and shipment of parasites not native to the north eastern states and the adjacent forests in Canada. The object of this work is to improve upon the biological control obtained by parasites that are native to that area. In 1947 colonies of a parasite not native to the Rocky Mountain region were received from the northeast, and exchanges of this sort may be expanded for species that promise to be effective in the new environment.

A discussion of the specific activities conducted in 1947 follows:

I. The Collection of Budworm Pupae in Colorado with the Object of Obtaining Parasites not Native to the Northeast For Liberation in That Area

In 1946 a number of colonies of the Larvaevorid parasite, Ceromasia auricaudata from Colorado were liberated in New York state and became established there. These parasites emerged from the host pupae and were shipped as puparia.

In 1947 it was felt that Hymenoptera parasites that emerge from the host pupae should be sought. Arrangements were made to send budworm pupae from Colorado to the Dominion parasite laboratory at Belleville, Ontario where parasites could be reared from them. A total of approximately 26,000 budworm pupae were collected in the vicinity of the Silesca Ranger Station which is located on the Uncompahgre National Forest about 20 miles south by west from the town of Montrose, Colorado. The budworm pupae reached the Belleville Laboratory in good condition but unfortunately the number of Hymenoptera parasites obtained from them was very disappointing. In fact, P. B. Dowden of the New Haven

Laboratory reports that only about 50 Hymenoptera, 30 of which were Itoplectus obesus, which already occurs in the east, were obtained. About 16 percent of the pupae were parasitized by Ceromasia auricaudata and approximately 2000 specimens of this fly were obtained. There is no data to show that the percent of Hymenoptera parasites was reduced by a very severe freeze that occurred in mid-June, but we have reason to believe that it reduced the budworm population and increased the time and cost of collecting the pupae that were sent to Canada.

It required 94.8 man days to make the pupal collection with temporary labor employed at $.65 per hour, except for drivers who were paid $.75 and $.05 per mile for the use of their cars in transporting collectors to the collecting area from Montrose and back again at night. The collections were started July 15, and terminated August 1. The average daily collection per man day was only 475.2 pupae. The pupae were sent to Canada in two shipments, one of 17,160 on July 25 and the other of 8,929 on August 2. More frequent shipments were not made because the pupae had to be sent via air express and the nearest service was at Grand Junction, Colorado about 75 miles away. The daily pupal collections were kept on ice obtained in Montrose, Colorado until they were shipped. The pupae were mixed with fresh sawdust and packed snuggly into strong cardboard cartons for shipment.

II. Parasites Obtained From Budworm Collections Made in the Locations Listed Below

Prior to 1947 no data had been obtained on the budworm parasite complex on the Carson and Uncompahgre National Forests. In 1945 and 1946 collections were made on the San Isabel in the vicinity of La Veta, Colorado and considerable information was obtained. However, this infestation almost disappeared for no apparent reason and it was felt that a collection in 1947 might give some significant information on the parasite situation when the budworm population was low. Table 1 and 2 gives the data obtained from the various collections that were made. These collections were made when the larvae were mature and a few were starting to pupate. It is most surprising that no Hymenoptera parasites were obtained from the pupae in these collections and there is no explanation for it. It will be noted that mortality of the budworm pupae was high. A great many of these pupae had deformed abdomens. That is, the abdomenal segments were shorter than normal and appeared to be pushed together. Dissections of a good many of the dead pupae failed to show insect parasites. A few of the pupae had a peculiar yellow-green material that was similar to the abdomenal content after Larvaevorids have emerged, but there was no evidence that these parasites had emerged from them. In 1946 no record was kept of the percent of parasitism of the larvae at La Veta but approximately 20.8 percent of the pupae were parasitized. In 1947 parasitism of larvae collected at La Veta was 4.6 percent and 27.05 percent in pupae that developed from them. It is a question whether parasitism at La Veta can be compared in this way because the 1946 data is based on a collection of roughly 65,000 larvae while that in 1947 is from only 500.

Table 3 gives the results obtained from dissecting 745 larvae that were alive when they were placed in alcohol to preserve them. Some of the larvae in the vicinity of the Silesca Ranger Station were taken from the same hosts on the same day but the locations were a mile or more apart. There is relatively little difference in the percent of mature larvae that were parasitized by

Glypta and Apanteles. The writer dissected these larvae with considerable care but he feels that the young Larvaevoridae larvae are being missed. The 92 larvae collected July 8 from Engelmann spruce in the vicinity of the Silesca Ranger Station has the least parasitism of any. There is no good explanation for this because all of the collections were from several trees in a locality and all of them were collected directly from the tips and placed in alcohol.

Table 4 gives part of the data obtained from dissecting larvae that died in rearing trays. A good number of these larvae died after parasites had emerged from them. There was a peculiar leather like texture to the bodies of a good many of the larvae. Some larvae seem to have been unable to molt their skins possibly due to injury or disease. One abnormal larvae was found which had 2 sets of legs and prothorax. Discolored, watery tissue was noted in some of the larvae which suggest a diseased condition.

III. Budworm Populations

A good measure of budworm populations for all stages of the insect has not been developed, but it is felt that leads are available which permit a degree of comparison between areas, and in the same area from year to year. The following data and observations were made in 1947.

Percent of buds infested

Table 5 presents data obtained from an examination of 70,222 buds distributed on 265 trees. The method used in sampling the majority of the trees was to examine 100 buds from each tree and record the number that were infested. The buds were on trees of various heights and in most instances they were from 3 to about 7 feet above the ground and from all sides of the tree. All of the buds on a few trees about 3 to 5 feet in height were examined, but the percent of infested buds was almost identical to a sample of 100 taken as indicated above.

Populations of mature larvae

No satisfactory method for measuring mature budworm larvae population has been devised, however, the data obtained from bud examination in 1947 seems to indicate something about the population that may be expected. It will be noted in Table 5, that the percent of infested white fir buds was one percent and much less on Douglas-fir. It required 8 man hours to collect the 500 larvae recorded in Table 1 from the same area. In 1946 no data was obtained on the bud infestation but on several occasions, 4000 to 5000 mature larvae were obtained in 8 man hours in this area. This gives some comparative idea of the population in the same area fromone year to the next. It is felt that the population of mature larvae at two points near Taos and one at El Rito varied more or less according to the number of infested buds. At El Rito for example, where 14.4 percent of the buds were infested, it required about one man hour to collect 1000 larvae and approximately twice as long to collect 1000 larvae at each of the two plots near Taos. The correlation between the number of infested buds and the estimated abundance of mature larvae did not hold in the vicinity of the Silesca Ranger Station due to a severe freeze in

mid-June which killed a high percent of the 1947 tips. The budworm population took a sharp drop following the freeze, and relatively few of the larvae matured and pupated. This enormous reduction is indicated by the fact that it required 94.8 man days to collect approximately 26,000 pupae or about 274.2 per man day.

IV. Effect of Freezing Temperatures June 11 and 12 on Tips of Budworm Host Trees In Vicinity of Silesca Ranger Station, Uncompahgre National Forest

In the morning of June 11 a cold wave came into the area bringing snow which fell throughout the day, part of the night and part of June 12. About 6 inches of snow, in spite of a great deal that was melted, was on the ground. The night of June 12 was clear, and cold enough to freeze a crust on the snow that would support a 170 pound man. Unfortunately no thermometer was available to get a recording of the temperature but it must have been near zero because most of the leaves on aspen, oak brush and many of the tips on the firs and spruce were frozen. At the time of the "freeze" most of the buds on Douglas-fir and alpine fir were open and the 1947 needles were as much as 1/2 inch long. The Engelmann spruce buds were not so far advanced and in most cases they had not opened or had done so just a few days prior to the cold wave. An examination of 100 tips taken at random on each of 20 Douglas-fir trees showed that 70.8 percent of them were frozen, a similar count on alpine fir showed that 82.15 percent were frozen and 53.15 percent of a comparable number of Engelmann spruce tips were frozen. It will be noted in Table 5 that counts made in the same area just prior to the cold wave showed budworm larvae in 17.05 percent of the alpine fir tips, 6.67 percent of the Douglas-fir tips and 8.76 percent of the Engelmann spruce tips.

Table 6 presents data obtained about a week after the freeze. An examination was made of 713 tips that were infested at the time or had been abandoned. From 314 larvae infested alpine fir tips that were frozen, it was found that 14.3 percent of the larvae were dead while one dead and 20 living larvae were found in tips that had not been frozen. In an effort to collect Engelmann spruce tips at random, 170 tips were obtained and live larvae were found in 14 frozen tips as well as in 156 tips that had not been frozen. No dead larvae were found in either of them.

On June 22, ten days after the freeze, 125 infested alpine fir tips were examined and it was found that in those that were not frozen 90 larvae were present and 8 had been abandoned while in frozen tips 11 live larvae were found, 14 tips had been vacated and 2 larvae were dead.

An effort was made to determine whether budworm larvae could survive and develop on branches that had nothing on them besides old needles and frozen tips. In this test, 11 celluloid cylinders were placed upon alpine fir branches with no 1947 needles that were not frozen. In each of the cylinders 10 larvae from frozen alpine fir tips were placed. The results of this is shown in Table 7. It will be noted that 34 moths developed from 110 larvae. Twenty other larvae survived long enough for Glypta and Apanteles to develop in and emerge from them. These data seem to indicate that under forced conditions of this type a fair survival is possible. Unfortunately the contents of the checks were discarded accidentally before the material was tabulated so we have no data for comparison.

On 14 Douglas-fir trees that ranged in height from 5 to 8 feet, a record was made of the number of budworm larvae that matured. This data was taken July 18 and at that time there was 98 budworm pupae and mature larvae and 12 other larvae had been killed by parasites (11 Glypta and 1 Apanteles). This makes an average of 7 budworm per tree with a range of 1 to 12. On 15 alpine fir only 46 budworm pupae and larvae matured or an average just over 3 per tree with a range of 0 to 7. Five larvae had been killed by Glypta. On 14 Engelmann spruce, 69 budworm pupae and larvae matured or an average of just under 5 per tree with a range of 0 to 13. Eight larvae were killed by Glypta.

The above records on mature budworm larvae, pupae and larval parasites were in the same area where counts were made on the number of infested buds recorded in Table 5. It is felt that the original infestation on these trees was similar to that in trees from which the data in Table 5 was obtained. Time did not permit counts to be made of the total number of tips on these trees so accurate reductions in the population cannot be given, but it is a question whether more than one percent of the original population reached maturity.

Populations of pine form budworm

Rough observations are all that have been made of the pine form budworm, but these indicate that in Colorado the population is lower than it was a few years ago. In Rocky Mountain National Park the infestation has almost disappeared in areas where a moderate amount of feeding occurred prior to 1945. In the Sugar Loaf Mountain area of the Roosevelt National Forest the population was light in 1947 and has maintained that level since 1945.

An infestation in the Black Hills was discovered in 1947 by Dr. N. D. Wygant, and in some areas the population caused almost complete defoliation. The population in this infestation rose rapidly, and if it continues considerable loss of ponderosa pine may be expected unless control measures are used. Dr. Wygant collected some larvae in 1947, but unfortunately the rate of parasitism or the parasite complex could not be obtained from them because many of the specimens died in transit from the Black Hills to the summer station at the Silesca Ranger Station and an unknown number of parasites succeeded in escaping from the carton in which the larvae were placed for shipment. Plans have been made to make collections in 1948, and also make observations on hibernation habits and certain other aspects of biology that have not been worked out for the pine form in this region.

V. Observations on the Larvaevorid Compsilura concinnata Received from the Forest Insect Laboratory at New Haven, Connecticut for Liberation Against The Budworm in Colorado and New Mexico

A shipment of 300 mated female Compsilura concinnata was directed to D. O. Scott of the Forest Service at Taos, New Mexico and a similar number to Forest Ranger Paul Martines at El Rito, New Mexico. A delay enroute caused high mortality in the flies sent to Taos, but those sent to El Rito had only 3 dead flies in it. These colonies were liberated July 20 in areas with high budworm populations, however, the 1947 brood of budworm larvae had matured, pupated and the moths had oviposited before the parasites were liberated. It is a question

whether many Compsilura were able to find alternate hosts in the areas where they were liberated because there were few noted. Collections of budworm larvae and pupae are planned for 1948 which should determine whether this parasite has become established.

On July 2, 1000 Compsilura puparia were received at Montrose, Colorado. These puparia were directed to Delta, Colorado and were held there for 2 days before reaching Montrose. The temperature was high and when the carton was opened the sawdust in which the puparia were shipped, felt warm. The temperature may have injured the specimens; however, no checks could be run to determine this point. The idea that something was wrong originates from the fact that only 422 flies emerged from the 1000 puparia. Emergence began July 4 and ended July 20. The peak of emergence was July 15. Several of the flies were deformed, and those that appeared normal did not react as they do in the eastern states. This abnormality is thought to be due to rather low temperatures that are more or less characteristic of the area around the Silesca Ranger Station where the work was done. Detailed records were made of the time and duration of copulation on 63 pairs. In this it was found that the flies were inactive until long after the sun came up, and in no case did copulation begin until 9:05 a.m. and they continued until 7:30 p.m. Out of 422 flies that emerged only 74 females were fertilized. The duration of copulation varied from 12 minutes to 6 hours and 27 minutes. Food in the form of honey water was provided on cotton pads that were soaked in the solution and placed in the mating cages. The flies fed throughout the day while temperatures were high enough for them to be active. A few parasites of Compsilura were obtained from the puparia, but these have not been sent in yet for identification. However, this will be done in the near future.

It is a question whether Compsilura would ever be an important parasite in budworm infestations in forests such as the Uncompahgre which has an elevation ranging between 9000 and 10,000 feet. At this elevation summer temperatures may not reach high enough to be suitable for this parasite.

VI. Biological Notes on Spruce Budworm

Comparison of larval growth

Table 8 contains data obtained from measuring budworm larvae collected on different hosts and on the same hosts on different dates. Unfortunately, collections of equal numbers were not taken from the 3 hosts but some comparisons are possible in this data. It is interesting to note that in 7 days larvae taken from alpine fir more than doubled their length. There is also an interesting difference in length between larvae taken on the same date from frozen and green foliage. There seems to be no material difference in the average length of larvae collected June 22 from frozen alpine fir tips and those from frozen Engelmann spruce tips. Engelmann spruce buds did not open for several days after the alpine fir, and it was felt at that time that larvae in the Engelmann spruce buds which had not opened were somewhat smaller than larvae on green alpine fir tips that had opened. Larvae were not collected to prove this point due to a shortage of time.

Pupation of the two sexes

Records were kept of a number of pupae separated to sex and from these it was found that male larvae pupated from 1 to 2 days ahead of the female and the male moths preceded the females in emerging by about the same time. There was, of course, a great many of both sex in the pupae and moth stage at the same time but invariably the first pupae and moths were males in all collections. This applied to both the fir form budworm as well as the pine form.

Moth Activities

A number of observations made in this region report that budworm moths are more active at night than during the day, but this characteristic was not found to hold in 1947 on the Uncompahgre National Forest. This statement is made on the basis of a good many attempts to see and attract moths to an electric lantern and also to automobile headlights, but in neither case did the moths show any tendency to come to the light or was it possible to see more than one or two in flight. Those thought to be budworm moths in flight were of questionable identity, because a few other species were in flight at the time and some of them did come to the lights. The moth population seemed lower than might have been expected even though the larvae population was greatly reduced by the mid-June freeze. Considerable time was spent looking for eggs and hibernating larvae but none could be found.

In Table 9 it will be noted that the average number of eggs found in gravid females did not run as high in this material as might be expected. Considerable care was used in making the dissections and counting the eggs, but a great many small eggs were encountered in a number of the females and a few unavoidable errors may be in these records. There were some differences noted in the abdomenal content of some of the females. In a number of them the abdomen was filled with fat-like material, and the abdomenal wall in others was thick and leather like in texture.

VII. Budworm Racial Studies

In the central and southern Rocky Mountain Region there is a form of the budworm identified as Archips fumifera which feeds upon ponderosa pine. This form has never been observed to feed upon the firs and spruces and conversely the form that feeds upon these hosts has not been known to feed upon pine in nature. There is a question in the minds of several people whether these are the same species. Some preliminary steps were taken in 1947 in an effort to obtain information on this point. On June 11, 1000 budworm larvae from Douglas-fir were placed in an open tray containing ponderosa pine tips and small branches, and 30 larvae from alpine fir were placed in a second open top tray with ponderosa pine branches. All of these larvae died by July 3 and there was little evidence of feeding on the pine.

Table 10 presents data obtained from caging 20 fir form larvae in each of 14 celluloid cylinders that enclosed the tips of ponderosa pine branches. A length of about 12 inches of the branch was enclosed. Several of the branches had catkins which were enclosed and the larvae fed extensively upon them.

The larvae for 7 of the cages was taken from alpine fir and the others from Engelmann spruce. The larvae averaged about 8 mm in length at the time they were put in the cages. It will be noted that moths developed in all but one of the cages, and from 23.56 percent of the larvae which is probably higher than occurred on their normal hosts in nature. In no case did the larvae, pupae or moths differ materially from the normal fir form. Unfortunately, time did not permit the moths to be removed from the cages until after they had died and were very badly broken. Two of the cages were exposed to the sun part of the day and in one case part of the needles inside died.

Small pine form larvae were collected June 20, by Jack Hay on Sugar Loaf Mountain near Boulder, Colorado and sent to Montrose. Some of these larvae were placed in 8 dram vials containing either tips from Douglas-fir, alpine fir or Engelmann spruce. Table 11, gives data from this work. The number of specimens involved is small but it does indicate that starting with small larvae it is possible for them to develop on succulent foliage from the trees indicated under forced conditions. The moths from these pupae were typical pine form type as were the larvae.

Attempts were made to cross fir form females with pine form males and vice versa but only in 2 cases did crosses take place. These crosses were between a pine male and a fir form female. Fertile eggs were laid and the larvae seemed to be in good condition when the jar in which they hatched was placed along with fir form larvae in other jars in cold storage at Rocky Mountain National Park to hibernate. A report of later developments will be written later.

VII. Surveys

A separate report has been made giving some details from a very incompleted survey that was made. At the present time it will be mentioned that with the close of 1947 the budworm infestation in Colorado is also about at a close. A very high population which has persisted in the higher elevations of parts of the Carson and Santa Fe National Forests in New Mexico has caused a great many trees to develop spike tops. There is reason to believe this infestation may remain high for some time, but a great many trees will be damaged or killed to add to the injury that has occurred to date. An epidemic of the pine form budworm has developed recently in the ponderosa pine in the Black Hills. Parts of the area is damaged more than others but a good many thousand acres had severe defoliation in 1947. Artificial control measures may be advisable if this infestation shows indication of persisting.

Summary and Conclusions

In 1947 the Fort Collins, Colorado Forest Insect Laboratory in its budworm project, emphasized the collection of budworm pupae which were shipped to Belleville, Ontario with the object of obtaining Hymenoptera parasites for liberation in the northeastern states. Approximately 26,000 pupae were collected and shipped, but due to a sharp reduction in the budworm population following a severe freeze in mid-June it required considerably more time to make the collection than was anticipated. The collection was made on the Uncompahgre

National Forest in southwestern Colorado in an area where no previous data on the parasite complex had been obtained. It proved to be unprofitable to make this mass collection without some idea of what might be expected, because almost no Hymenoptera parasites were obtained from the pupae, and most of those were species that already occur in the eastern states.

A severe freeze in mid-June killed a high percent of the tips on alpine fir, Douglas-fir and many on Engelmann spruce which are the budworm hosts on the Uncompahgre National Forest. The great reduction in food together with parasites and other unknown factors caused a sharp reduction in the budworm population. It seems probable that if adverse weather conditions can reduce budworm populations, favorable weather should do the reverse. If this is correct, it would appear that outbreaks might be anticipated before they occur by knowing the factors that favor them.

A need is felt for practical techniques that will make it possible to determine whether budworm populations are changing so that comparisons may be made from year to year and one area with another. In 1947 data was obtained by counting the number of infested buds per 100 on 10 or more trees in a small locality. The relative abundance of mature larvae in the same areas was estimated to be quite similar to the infestation that was found in the buds.

The question has frequently been raised whether the budworm which attack the firs and spruce in this region is the same species as the one which works on ponderosa pine. In 1947 fir form larvae enclosed in celluloid cylinders on ponderosa pine produced moths which were similar to those that developed on their normal host. Pine form larvae developed on alpine fir, Douglas-fir and Engelmann spruce and in each case the moths were like those that developed on pine. Corss mating the fir and pine form moths resulted in 2 pine form males fertilizing 2 fir form females which produced eggs that hatched and the larvae hibernated. No other crosses were successful out of a number that were tried. This work should be continued.

A very incomplete survey indicates that the budworm has all but disappeared from the forests in Colorado. A high population has persisted for several years in parts of the Carson and Santa Fe National Forests in northern New Mexico and there is reason to believe it will continue for some time. An outbreak of considerable size was discovered in the Black Hills and Harney National Forests on ponderosa pine. This infestation may cause considerable damage if it persists for a few years, but high populations have, as a rule, not lasted on pine in this region.

The writer wishes to acknowledge many helpful suggestions and assistance from Dr. N. D. Wygant, Entomologist in Charge of the Fort Collins Laboratory. Suggestions and help from the Forest Insect Laboratory at New Haven, Connecticut are greatly appreciated. Special mention is made of P. B. Dowden and R. C. Brown. Mr. Harold Elmer who assisted with the field work was most helpful. Space and other working facilities was generously provided by the U. S. Forest Service. Special recognition is given to Ranger and Mrs. Bruce Torgney who were at the Silesca Ranger Station. Mr. David Scott of the Carson National Forest at Taos, New Mexico and Ranger Martines at El Rito were very cooperative and they went to considerable trouble to receive and liberate the colonies of Compsilura concinnata that were sent to them by the New Haven Laboratory. These men also spent time in the forest making observations on the budworm situation with the writer. Leonard Dearborn of the Santa Fe National Forest was most helpful in an examination of the budworm infested area in the vicinity of Rio Las Vacas.

TABLE I. PARASITE COMPLEX IN BUDWORM LARVAE COLLECTED AT PLACES INDICATED

Larvae Collected At	Number Larvae			Number and Species of Parasites from Larvae						
	Collected	Pupated	Died	Glypta	Apanteles	Phytodietus	Madreymia	Actia	Total	% Parasitism
LaVeta, Colo.	500	399	78	13	3	3	3	1	23	4.6
Taos, N.M. Plot 1	1000	391	483	73	42	0	11		126	12.6
" " Plot 2	1000	395	567	28	2	3	5		38	3.8
El Rito, N.M.	1000	408	467	85	11	7	22		125	12.5
Poncho Pass, Colo.	300	154	111	24	4	2	5		35	11.66
Silesca R.S. from										
Alpine fir	500	220	205	61	5	1	3		70	14.0
Engelmann spruce	500	311	135	40	5	3	3	1	52	10.4

TABLE II. PARASITE COMPLEX IN BUDWORM PUPAE FROM LARVAE COLLECTED AT PLACES INDICATED

Pupae From	No.	Number Pupae		Number and Species of Parasites from Pupae					
		Transferred	Died	Ceromasia	Winthemia	Madreymia	Actia	# Parasites	% Parasitism
LaVeta, Colo.	377	99	176	95	2	5	0	102	27.05
Taos, N.M. Plot 1	391	53	209	0	0	6	1	7	1.8
Taos, N.M. Plot 2	395	156	233	1	5	0	0	6	1.52
El Rito, N. M.	408	175	176	19	28	8	2	67	15.44
Poncho Pass, Colo.	154	84	69	1	0	0	0	1	0.64
Silesca R.S. from									
Alpine fir	220	142	41	22	11	4	0	37	16.8
Engelmann spruce	311	139	143	18	7	3	0	29	9.32

TABLE III. NUMBER PARASITES FOUND IN DISSECTED BUDWORM LARVAE

Location	Collection Date	No. Larvae		Parasites Recovered			Percent Parasitized	Remarks
		Dissected	Not Parasitized	Glypta	Apanteles	Miscellaneous		
Silesca R. S.								
Various hosts	June 5	15	13	2	—		13.33	
Engelmann spruce	" 17	50	45	2	3		10.00	
Alpine fir	" 22	67	58	5	4		13.43	Frozen tips
Alpine fir	" 22	35	28	4	3		20.00	Green tips
Engelmann spruce	" 22	76	64	10	2		15.79	
Engelmann spruce	July 8	92	88	4	—		4.35	
Alpine fir	" 8	83	63	18	2		24.16	
Engelmann spruce	" 10	17	13	3	1		22.20	
Engelmann spruce	" 10	54	42	12	—		22.20	
Alpine fir	" 10	51	39	11	—	1 Larvaevoridae	21.68	
El Rito, N. M.	June 27	98	79	17	2	1 Phytodietus	20.41	
Taos, N.M.Plot 2	" 27	107	85	20	2	1 Larvaevoridae	21.49	
TOTALS		745	617	108	28		18.32	

TABLE IV. DISSECTION DATA FROM BUDWORM LARVAE THAT DIED IN REARING TRAYS

Location	Collection Date	No. Larvae		Parasites Recovered			Percent Parasitized	Remarks
		Dissected	Not Parasitized	Glypta	Apanteles	Miscellaneous		
El Rito, N. M.	June 27	41	—	—	—	2 Phytodietus 2 Larvaevoridae	—	Several larvae appear diseased
Taos, N.M. Plot 1	" 27	105	—	—	—	3 Larvaevoridae	—	54 larvae mumified
" " Plot 2	" 27	48	—	—	—	—		18 " "
La Veta, Colo.	" 26	10	—	—	—	2 Larvaevoridae	—	7 leather like skins
Silesca R. S.	July 8	52	—	—	—	2 "	—	28 "
" "	" 8	23	—	—	—	2 "	—	15 "
TOTALS		279				13		

TABLE V. NUMBER OF BUDS INFESTED WITH BUDWORM LARVAE IN THE TREE SPECIES AND LOCATIONS INDICATED

Location	Number Trees Examined	TREE SPECIES EXAMINED											
		ALPINE FIR			DOUGLAS-FIR			WHITE FIR			ENGLEMANN SPRUCE		
		Number Buds		Percent	Number Buds		Percent	Number Buds		Percent	Number Buds		Percent
		Examined	Infested	Infested	Examined	Infested	Infested	Examined	Infested	Infested	Examined	Infested	Infested
La Veta, Colo.													
Spring Creek 5/21/48	22 W.F.*, 21 D.F.*				1907	2	0.10	2174	22	1.01			
Baker Creek 5/21/48	10 W.F.							677	0	0.0			
Indian Creek 5/23/48	16 W.F.							1251	4	.32			
Taos, N. Mex.													
Del Rio Canyon 5/25/48	10 W.F., 8 D.F.				800	38	4.75	1000	69	6.90			
Pueblo Creek Canyon 5/24/48	19 W.F., 7 D.F.				804	11	1.37	1409	37	2.63			
Alamitas Canyon 5/26/48	5 E.S.*, 5 A.F.*	500	56	11.2							500	47	9.40
El Rito, N. Mex. & vicinity 5/27/48	20 W.F., 12 D.F.				1200	83	6.92	2000	288	14.40			
Poncho Pass 5/28/48	10 D.F.				1000	15	1.50						
Silesca Ranger Station	30 D.F., 20 A.F., 50 E.S.	2000	341	17.05	3000	200	6.67				5000	438	8.76

* W.F. - White Fir; * D.F. - Douglas-fir; * A.F. - Alpine fir; * E.S. - Engelmann spruce

TABLE VI. NUMBER OF TIPS FROZEN IN MID-JUNE AND THE EFFECT OF THE FREEZE ON BUDWORM LARVAE IN THE VICINITY OF THE SILESCA RANGER STATION ON THE UNCOMPAHGRE NATIONAL FOREST 1947. EXAMINATIONS WERE MADE 4 to 6 DAYS AFTER FREEZE

Host Tree	NUMBER TIPS EXAMINED					
	Frozen tips With			Living Tips With		
	Live larvae	Dead larvae	Larvae gone	Live larvae	Dead larvae	Larvae gone
Alpine Fir	267	47	200	20	1	8
Engelmann spruce	14			156		
TOTAL	281	47	200	176	1	8

TABLE VII. NUMBER OF BUDWORM MOTHS THAT DEVELOPED IN CELLULOID CAGES FROM LARVAE PLACED AT THE RATE OF 10 PER CAGE ON SMALL ALPINE FIR BRANCHES ALL THE TIPS OF WHICH HAD BEEN FROZEN. LARVAE CAGED JUNE 20 AND CAGES EXAMINED DECEMBER 23-24, 1947.

Cage No.	Moths Emerged		Oviposited in cage	Dead Pupae	No. Parasites		Remarks
	Male	Female			Glypta	Apanteles	
1	2	2					
2	1	1		1	1		
3	1	2			1		Most of branch in cage dead
4	2	2					
5		5			1		
6	1				4		
7	3	1					
8	1				4		
9		5					
10	2				5		
11	1	2			3	1	
TOTAL	14	20	5	1	19	1	

TABLE VIII. LENGTH OF BUDWORM LARVAE TAKEN AT DIFFERENT TIMES FROM DIFFERENT HOST IN THE VICINITY OF THE SILESCA RANGER STATION

Date Larvae Collected	Number Larvae Measured	LENGTH OF LARVAE TAKEN FROM									Remarks
		Douglas Fir			Alpine Fir			Engelmann spruce			
		Average	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	
June 9	34	7.3 mm.	11 mm.	5 mm.							
" 15	45				5.04 mm.	13 mm.	6 mm.				
" 17	50							7.6 mm.	15 mm.	4 mm.	
" 17	50				8.42 mm.	15 mm.	6 mm.				
" 22	67				10.43 mm.	19 mm.	6 mm.				Frozen tips
" 22	35				12.43 mm.	17 mm.	8 mm.				Green tips
" 22	76							9.09 mm.	15 mm.	5 mm.	Frozen tips

TABLE IX. NUMBER OF EGGS FOUND IN GRAVID FEMALES THAT DEVELOPED FROM LARVAE TAKEN FROM LOCATIONS INDICATED

Location of Collection	No. Moths Dissected	Number Eggs			Remarks
		Average	Max.	Min.	
Taos, N. M. Plot 1	23	93.57	122	30	All eggs were small in some of the moths
Silesca R. S.					
Engelmann spruce	16	160.69	203	108	Many small eggs made accurate count difficult
Alpine fir	16	170.37	227	102	to make on some females.
LaVeta, Colo.	17	114.47	225	26	
Taos, N. M. Plot 2	17	153.06	223	90	
El Rito, N. M.	17	142.41	213	77	

TABLE X. NUMBER MOTHS THAT DEVELOPED FROM 20 FIR FORM LARVAE IN EACH OF 14 CAGES ON PONDEROSA PINE

Larvae from Alpine Fir	Number Moths		Number Dead Pupae		Larvae Killed by		
Cage No.	Male	Female	Male	Female	Glypta	Apanteles	Remarks
1	3	1					
2	1	-					
3	1	1					
4	2	2					
5	1	3					
6	6	7					Moths somewhat smaller than fir form
7	1	5					
Engelmann spruce							
1	4	4					2 live pupae
2	1	2					2 " "
3	2	3	1		1		Larvae fed on catkins in cage
4	3	3			1		" " " " " "
5	4	4					" " " " " "
6	-	-	1	1	2		Small holes in cage sleeve
7	1	1					Pine needles partly dead from sun scald
TOTAL	30	36	2	1	4		

TABLE XI. NUMBER PUPAE THAT DEVELOPED FROM PINE FORM LARVAE WHICH WERE CONFINED IN 8 DRAM VIALS WITH FOLIAGE FROM THE TREES INDICATED

Vial No.	Number of Larvae in Vial With						Remarks
	Douglas-fir		Engelmann spruce		Alpine fir		
	Start	Pupated	Start	Pupated	Start	Pupated	
1			8	4			All pupae were placed together in jars as rapidly as they formed. There was no reason to believe moths would not emerge from them and those not injured did emerge. All of the moths were typical pine form.
2	8	5					
3	6	1					
4					10	3	
5			2	1			
6					3	1	
7			2	2			
8			10	4			
	42.86% pupated		50.0% pupated		30.77% pupated		